SANITATION DISTRICTS OF LOS ANGELES COUNTY

A Megawatt Made is a Million Dollars Earned: Energy Production from Digester Gas

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Innovative Energy Management Workshop
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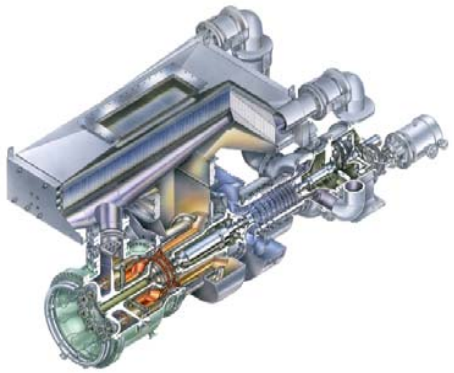
Presentation Overview

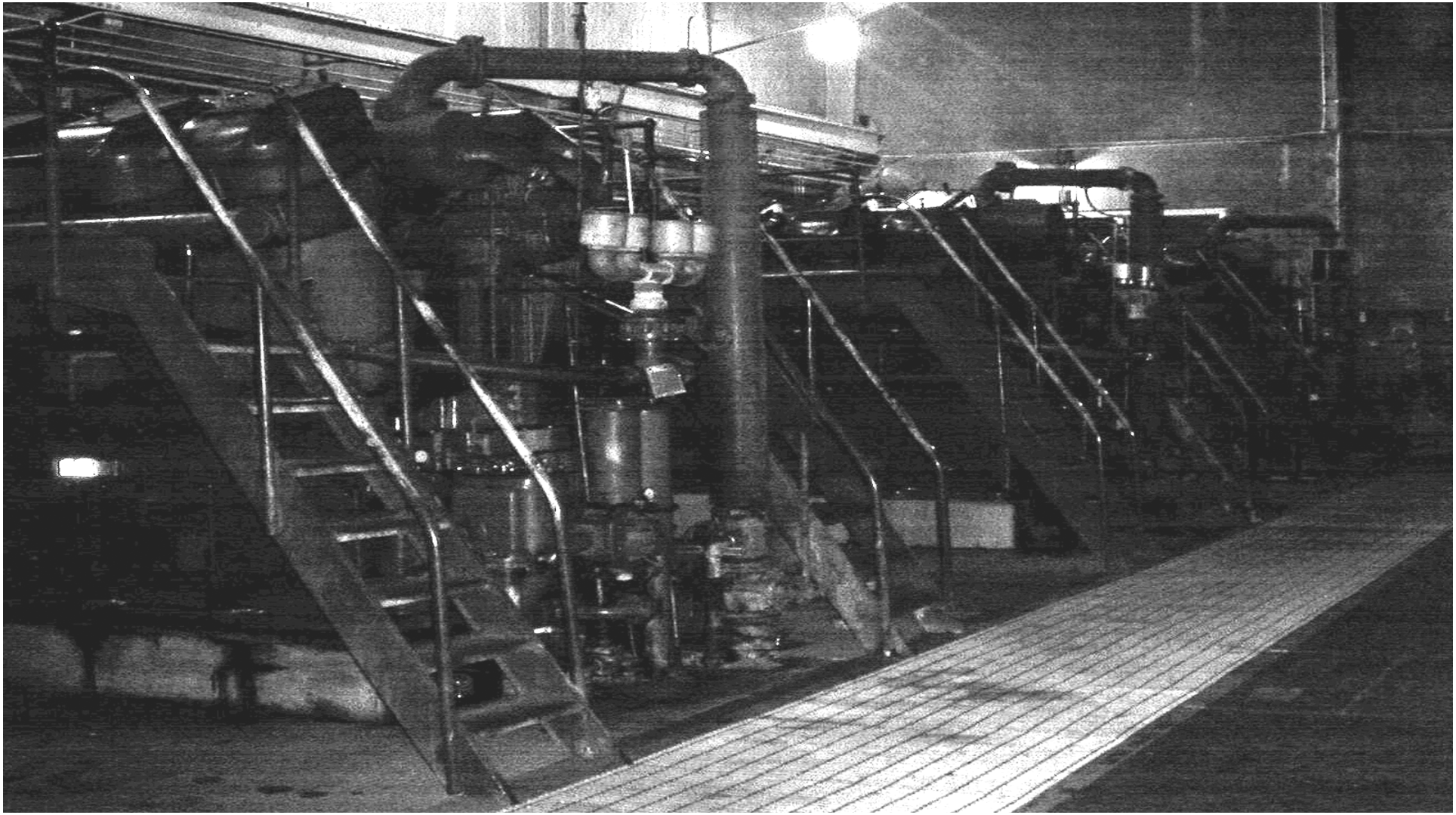
- Districts Energy Program
- Technology Review
- Capital and Operating Costs
- Barriers to Energy Recovery
- A paper with more details available from the speaker

Districts Energy Management Program

- Maximum development of bio-gas resources
- Minimize energy usage
- Minimize procurement cost and maximize sales income
- Demonstrate new technologies that reduce air emissions



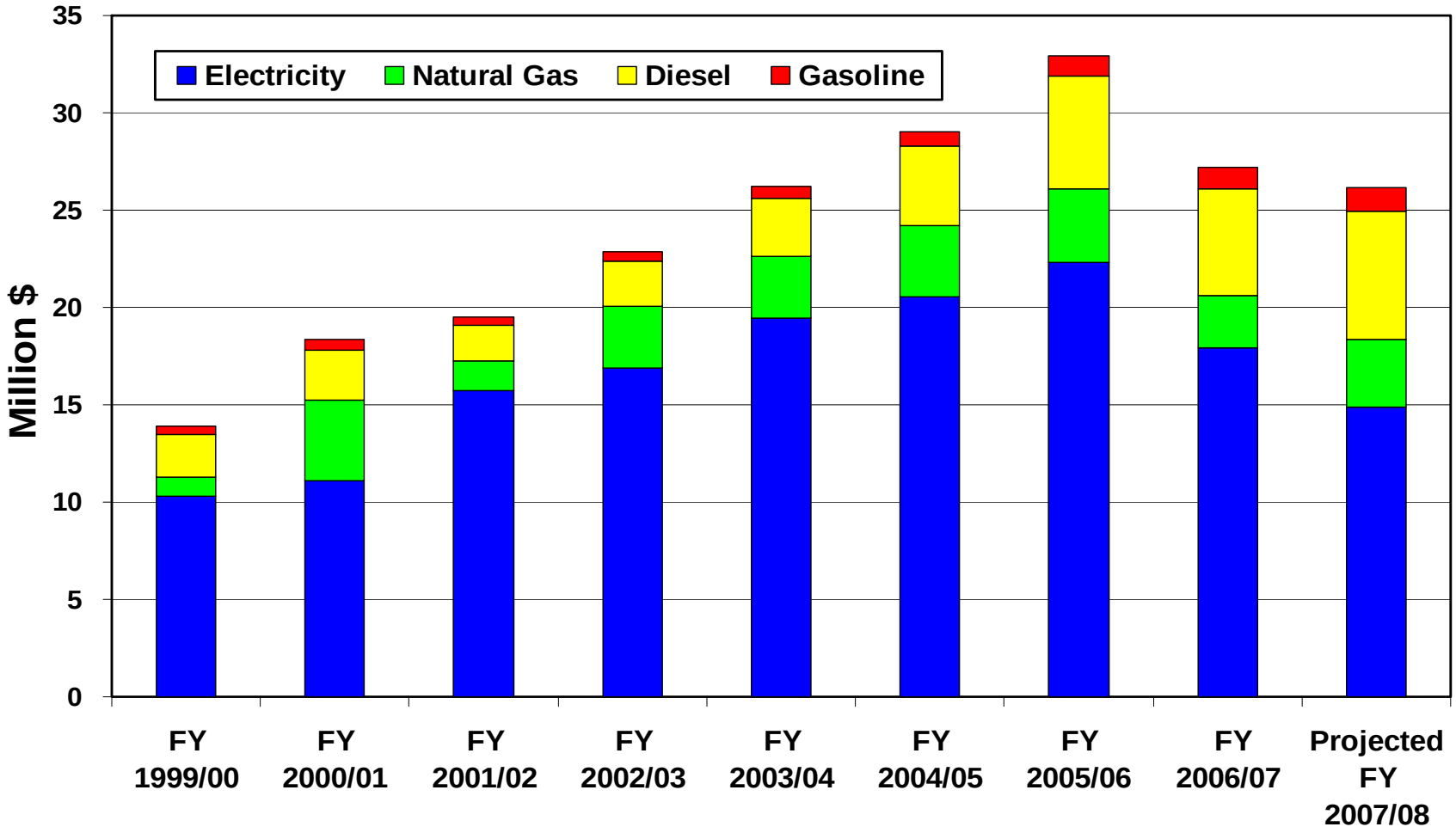
IC POWER ENGINE INSTALLED at JWPCP in 1938



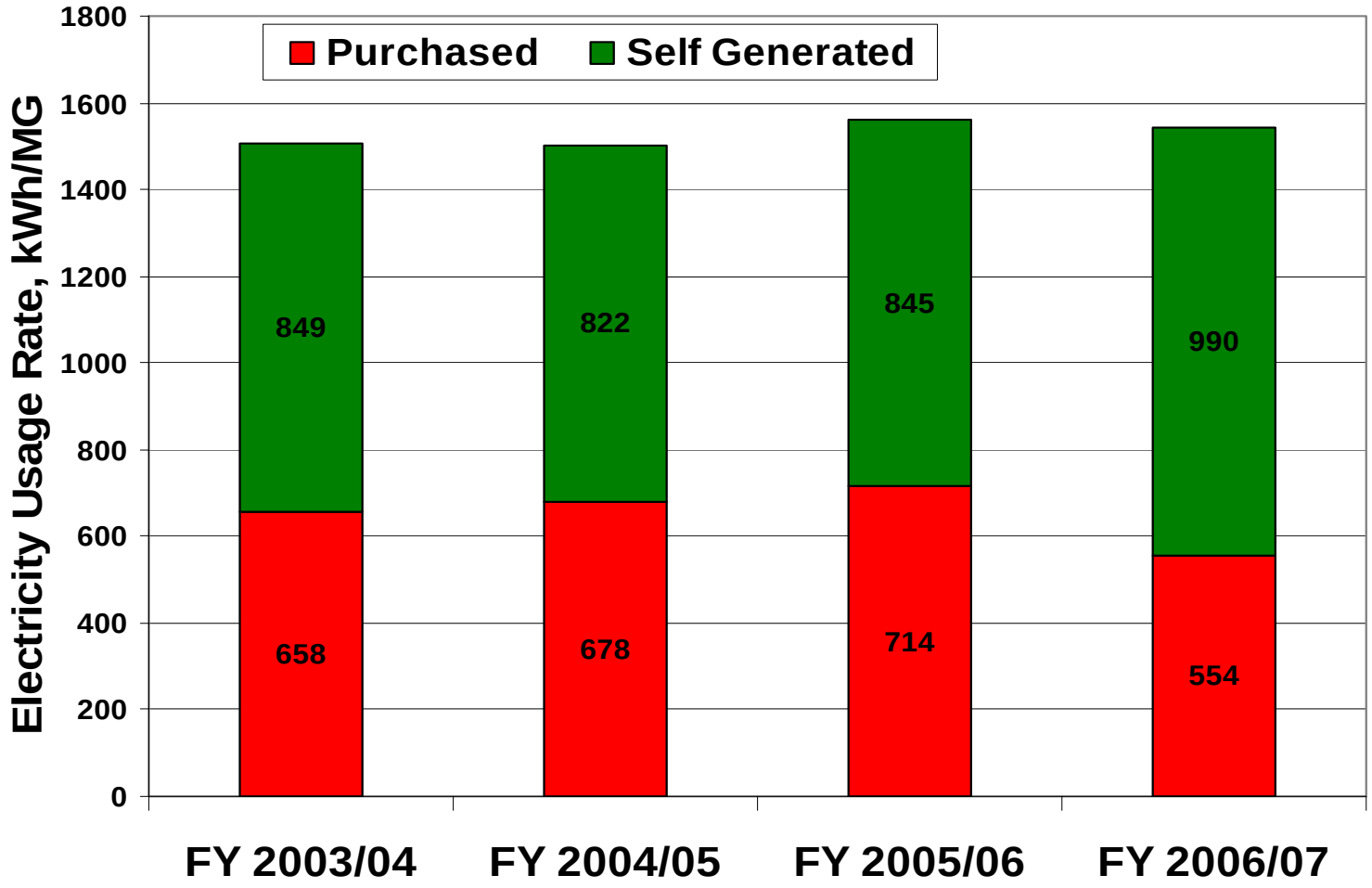
Why Self Generation?

- Save and Make Money
  - Displace Expensive Retail Purchases
  - Renewable Energy Credits Can Be Sold in 2009
- Reduce Emissions
- Reduce Global Warming
- Increased Redundancy
  - Digester Heating (Cogeneration)
  - Decrease Run Hours on Standby Generators

Historical Energy Expenditures at LACSD



System Wide Wastewater Treatment Plant Power Consumption



Existing Districts Digester Gas-Fired Facilities

- Boilers
  - Digester Gas for Heating
- Turbines
  - JWPCP 22 MW (400 MGD)
- Engines
  - Valencia 0.4 MW (12.5 MGD)
- Microturbines
  - Lancaster 250 kW (10 MGD)
- Fuel Cell
  - Palmdale 250 kW (15 MGD)

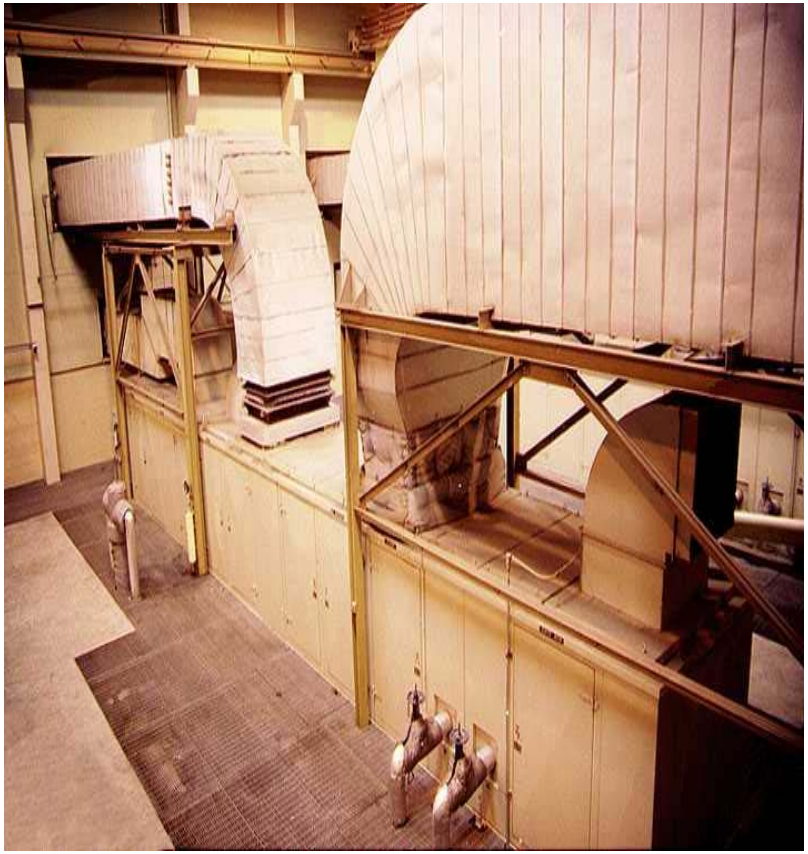
Energy Recovery Equipment

- Gas Turbines — 1 MW to 15 MW
- IC Engines — 25 kW to 3 MW
- Fuel Cells — 200 kW to 2 MW
- Microturbines — 30 kW to 250 kW
- Emerging technology-conversion of digester gas to natural gas (not covered in this presentation)

Gas Turbines

- Medium to High Efficiency
- Low Operating & Maintenance Cost
- Higher Installed Cost
- Excellent for Heat Recovery
- Island Operation

JWPCP Total Energy Facility



Location - Carson, California

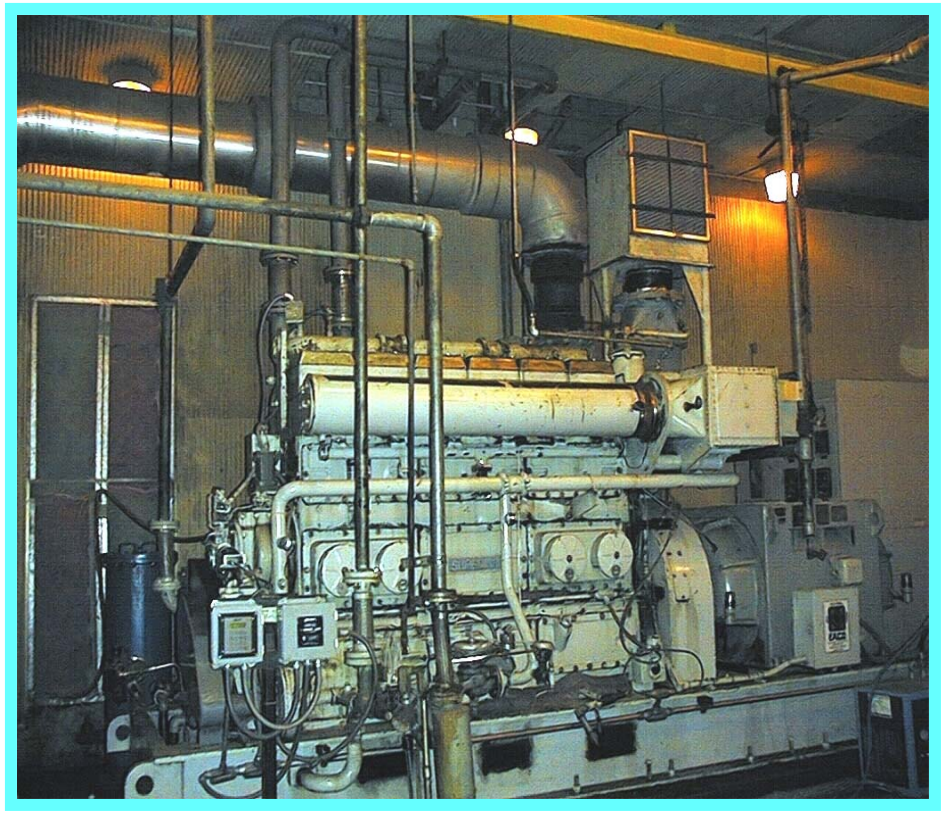
Combined Cycle Cogeneration Power Plant

- Three 9 MW Solar Mars T-13000 gas turbine generators
- One 3 MW DeLaval HJT steam turbine generator
- Offsets $15-20MM/yr in electricity purchases

IC Engines

- Higher Air Emissions
  - SCAQMD Rule 1110.2 may kill market
- High Efficiency
- Inexpensive
- Suppliers
  - Waukesha
  - CAT
  - Jenbacher
  - Deutz

IC Engine Cogeneration Facility at Valencia WRP



Location - Valencia, CA

- 500 kw Cooper-Superior Model 6GTLA Engine Generator
- Steam used to heat digesters
- Will be shut down in 2009 due to expense of air compliance

Fuel Cells

- Near Zero Air Emissions
- High Efficiency
- Expensive, but subsidized
  - PUC Rebates $4500/kW in California
- Two Suppliers
  - Fuel Cell Energy — 300 kW modules
  - UTC? — Availability unclear

Palmdale Fuel Cell Project

- Fuel Cell Energy molten carbonate fuel cell
- 250 kW, 47% efficiency (LHV)
- Heat recovery to heat water for digesters
- Combined heat and power efficiency 73%
- Startup completed Jan 2005
- Capital cost $1.9 million (before 50% rebate)
- 50% of cost recovered from SGIP

Microturbines

- Low Air Emissions
- Medium Efficiency – High Temperature Exhaust
- Cost Effective
- Two Suppliers in California
  - Capstone — 30 kW, 60 kW, 200 kW
  - Ingersoll Rand — 70 kW, 250 kW

Lancaster Microturbine Project

- Ingersoll Rand microturbine
- 250 kW gross, 32% efficiency (LHV)
- Heat recovery to heat water for digesters
- Combined heat and power efficiency 51%
- Capital cost $684k
- 40% of cost recovered from California Self Generation Incentive Program (SGIP)

Calabasas Landfill Microturbine Facility- Ten Capstone 30 kW

Digester Gas Cleanup

- Digester gas is not natural gas
- Some technologies require removal of gas contaminants
- Can add up to 2 cents/kWhr to O&M costs

Siloxane Removal

- Required for fuel cells, microturbines, engines or turbines w/ NOx or CO catalysts
- Optional for turbines or engines w/out catalysts-cost based decision
- Sorbents
  - Effective
  - Need to monitor for breakthrough and replace sorbent
- Pressure Swing Absorption
  - Continuous operation
  - Requires flaring of off gas, loss of 2-8% of fuel heating value
- Deep Chilling
  - No longer considered commercially available

Sorbent Based Fuel Skid

Other Contaminants

- Fuel cell requires removal of sulfur compounds, VOCs, chlorinated VOCs
- Future application of catalysts on engines may require removal of S, Cl

Self Generation
Cost Summary Comparison

	Installed Cost ($/kW)	Operating Cost ($/kWh)	Power Production Cost* ($/kWh)
Gas Turbines	$2,000	$0.010	$0.04
IC Engines	$1,700	$0.015	$0.04
Microturbines	$3,000	$0.016	$0.06
Fuel Cell	$8,500	$0.035	$0.16

*10 year write down @5%

Challenges

- Many technologies are new
  - Track record
  - Number of suppliers
  - Experience and resources of some suppliers
- Institutional barriers
  - Air agencies
  - Electric utilities

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